

# **Giant Magnetoresistive (GMR) Sensor Microelectromechanical System (MEMS) Device for Nondestructive Evaluation (NDE) Health Monitoring Applications for International Space Station (ISS)**

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With the imminent launch of the first International Space Station modules, NASA Office of Safety and Mission Assurance, specifically the Code Q Nondestructive Evaluation Program, is addressing issues of on-orbit station structural health monitoring. As part of this effort, Jet Propulsion Laboratory is working with NASA LaRC on development of novel devices and sensors for an NDE tool kit intended to be used by Station Astronauts for non-intrusive structural health assessment. JPL is currently investigating applicability of giant magnetoresistive technology, originally developed for high-density magnetic media, married to state of the art microelectromechanical systems (MEMS) for application as an acoustic sensor. In addition to space applications, these devices would have wide spread applicability in earthbound environments such as continuous/intermittent health monitoring of aircraft, hazardous process machinery and many other applications.

This paper discusses the fabrication aspects of an accelerometer device that is based on a sputter deposited, multilayer, and giant magnetoresistive field sensor. The device consists of a micromachined microstructure (membrane, cantilever beam, bridge) and a sputtered hard magnetic film. The device detects acceleration by sensing changes in magnetic field caused by the displacement of the hard magnetic film on the microstructure. Utilizing the bulk micromachining approach, very thin (0.5 – 1  $\mu\text{m}$ ) silicon and silicon nitride membranes are fabricated by means of anisotropic etching of silicon wafers and/or reactive ion etching of silicon on insulator (SOI) or Low Pressure Chemical Vapor Deposited (LPCVD) silicon nitride films over silicon substrate. The primary objective of our program is to study spin valve structures (giant magnetoresistance in magnetic multilayers) and microelectronics fabrication issues in devices that exhibit the large magnetoresistive effect. A reliable GMR/MEMS device should have the following characteristics; a significant percentage change in resistance, high field resistance, low resistance noise, and a high bandwidth. These characteristics are very sensitive to the thickness of the various layers in device multilayers, the composition and microstructure of the individual layers. The eventual goal of our project is to optimize the giant magnetoresistive behavior of the device using a design of materials approach. Deposition and patterning of hard magnetic film over the microstructure and the bonding of microstructure over the GMR element will be discussed. We will present the fabrication and reliability issues associated with GMR devices.

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